Approximation formula for option prices under Rough Heston model and short-time implied volatility behaviour

ABSTRACT

Rough Heston model possesses some stylized facts that can be used to describe the stock market, i.e., markets are highly endogenous, no statistical arbitrage mechanism, liquidity asymmetry for buy and sell order, and the presence of metaorders. This paper presents an efficient alternative to compute option prices under the rough Heston model. Through the decomposition formula of the option price under the rough Heston model, we manage to obtain an approximation formula for option prices that is simpler to compute and requires less computational effort than the Fourier inversion method. In addition, we establish finite error bounds of approximation formula of option prices under the rough Heston model for $0.1 \leq H < 0.5$ under a simple assumption. Then, the second part of the work focuses on the short-time implied volatility behavior where we use a second-order approximation on the implied volatility to match the terms of Taylor expansion of call option prices. One of the key results that we manage to obtain is that the second-order approximation for implied volatility (derived by matching coefficients of the Taylor expansion) possesses explosive behavior for the short-time term structure of at-the-money implied volatility skew, which is also present in the short-time option prices under rough Heston dynamics. Numerical experiments were conducted to verify the effectiveness of the approximation formula of option prices and the formulas for the short-time term structure of at-the-money implied volatility skew.

Keyword: Rough Heston model; Decomposition formula; Approximation formula for implied volatility